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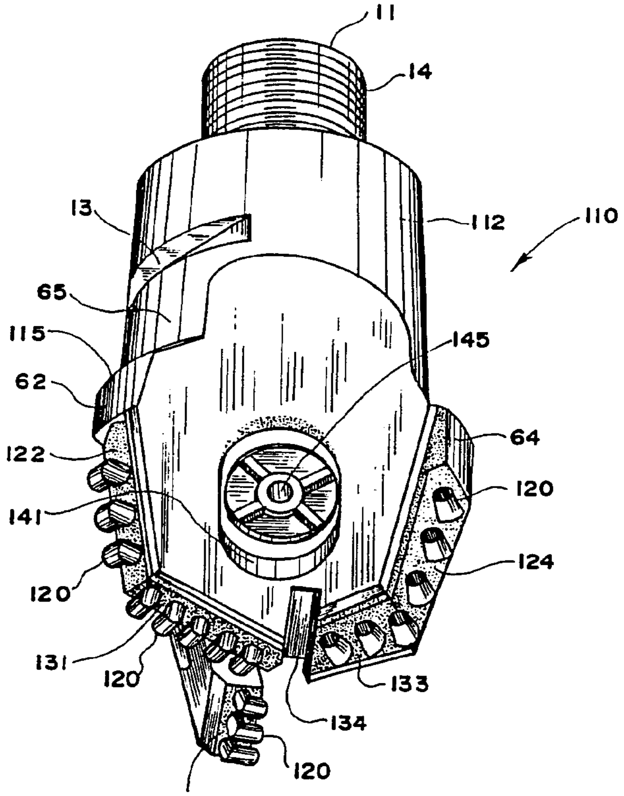
(54) Title: TRIANGULAR OIL WELL DRILL BIT

(57) Abstract

A drill bit (10) for use in unconsolidated formations includes a generally triangular cross-section that tapers toward the lower tip end (34) of the tool (10). The vertices of the triangular cross-section carry blade members (22, 23, 24) that cut and define the size of the bore hole. Nozzles (45, 46, 47, 48) positioned between the blades (22, 23, 24) upon the tapered portion (66) of the tool and on the uppermost surface of the drill head break up unconsolidated formation material that has been cut. Tooth-like projections (20) or inserts (120) made of materials such as tungsten carbide and polycrystalline diamonds and the like are carried on the blades and spaced apart from one another so that each blade makes a one-third cut into the formation during a single rotation of the drill head.



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TRIANGULAR OIL WELL DRILL BIT

SPECIFICATION

Cross Reference to Related Applications:

This is a continuation-in-part of copending U.S. Patent Application Serial No. 07/344,100, filed April 6, 1989, which is a continuation-in-part of U.S. Patent Application Serial No. 07/077,612, filed July 24, 1987, which is a continuation of application Serial No. 06/882,228, filed July 7, 1986, now United States Patent No. 4,683,965, issued August 4, 1987. These prior applications are hereby incorporated by reference.

BACKGROUND OF THE INVENTION:

1. Field of the Invention

The present invention relates to oil well drill bits, and more particularly relates to an improved unitary drill bit having particular utility when drilling in medium to hard unconsolidated formations.

2. General Background

When drilling for oil in unconsolidated formations such as those found along the United States and the offshore waters of the Gulf of Mexico, the consistency of the formations ranges from soft to medium to hard. Even when drilling in the harder unconsolidated formations, "bit balling" is a common problem. This problem results from a heavy accumulation of clay-like material found in the formation which gathers around the bit as it rotates through the formation. The clay-like material actually adheres to the bit rather than flowing away after being cut.

Patents related to drill bits used in oil and gas drilling operations include U.S. Patent No. 4,683,965, as well as U.S. Patent Nos. 2,169,223; 1,733,241; 2,490,208; 2,169,223; 1,887,372; 2,838,284; 2,673,716; 2,756,023; 3,043,384; 3,145,790; 4,515,227; and Russian Patent No. 840,272.

Drill bits having tooth-like projections, commonly known as inserts, made of materials sus as tungsten carbide and polycrystalline diamonds and the like, are used in drilling medium to hard formations. Representative drill bits are shown in the 1984-85 General Catalog of Smith Tool, a Division of Smith International, Inc.

SUMMARY OF THE INVENTION:

The present invention is an improvement over prior art drill bits, the preferred embodiment thereof providing a unitary drill bit having a generally triangular shaped cross-section which also narrows at its tip portion, providing three cutting blade portions at the apex of the triangular cross-section of the bit and three flat surfaces spanning between the cutting blades which enhance flow characteristics, i.e., the removal of cuttings through the use of drilling fluids as the well bore is drilled through the formation. Jets are provided between the blades and positioned on the flow surface. Jets may also be positioned on the uppermost flat surfaces of the drilling head which surfaces extend from the cylindrical portion of the drill bit that connects with the drill string. Jets positioned on the upper surfaces of the drill head face away from the drill head and up the well bore toward the drill string so that the drilling fluids will blast even particularly gummy cuttings away from the cylindrical portion of the drill bit. The blades are relatively short so that the close proximity of the jets to the formation enhances the blast of drilling fluids. Each of the three blades carries tooth-like projections or inserts made of tungsten carbide, polycrystalline diamonds and the like. The size of the projections or insets ranges from one-half inch (1.27 cm) to one inch (2.54 cm) wide. The spacing between the projections or inserts generally range from one-half inch (1.27 cm) to three-quarters of an inch (1.905 cm), but may be increased to one inch (2.54 cm). The position of the inserts is staggered on each blade so that each blade will make a one-third (1/3) cut during a rotation of the drill head. The cutting surface of the projections or inserts is rounded to prolong the life of the insert, since a flat cutting surface generates friction and heat as it cuts into formation and quickly deteriorates the projections.

An object of the invention is to provide a drill bit which will perform in medium to hard unconsolidated formations and overcome the problem of "bit balling".

Another object of the present invention is to provide a drill bit carrying tooth-like projections or inserts spaced apart from one another and positioned on each blade so that each blade will make a one-third (1/3) cut in the formation during a rotation of the drill head.

Another object of the present invention is to provide a drill bit having relatively short blades so that the close proximity of the jets to the formation enhances the blast drilling fluids.

BRIEF DESCRIPTION OF THE DRAWINGS:

For a further understanding of the nature and objects of the present invention, reference should be had to the following detailed description, taken in conjunction with the accompanying drawings, in which like parts are given like reference numerals, and wherein:

Figure 1 is a side view of the preferred embodiment of the apparatus of the present invention.

Figure 2 is a side view of the preferred embodiment of the apparatus of the present invention.

Figure 3 is a side view of the preferred embodiment of the apparatus of the present invention.

Figure 4 is an end view of the preferred embodiment of the apparatus of the present invention.

Figure 5 is an end view of the alternative embodiment of the apparatus of the present invention.

Figures 6 and 7 show various orientations of the inserts in relation to the surface of the cut.

Figure 8 is a side view of the alternative embodiment of the apparatus of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT:

Figures 1 and 2 illustrate generally the preferred embodiment of the apparatus of the present invention designated generally by the numeral 10. Drill bit 10 includes a tubular body 12 having at its upper end portion threaded section 14 which is adapted to threadably attach to a drill string D shown in phantom lines in Figure 1. The tool body 12 can provide indentations 13 with flat surfaces, for example, so that a wrench, power tong or the like can be attached to the tool body 12 so that the tool body 12 can be tightened with respect to the drill string D. The central longitudinal axis of tool body 12 is designated as X-X in Figure 1. The center of cylindrical bore 11 (not shown) would coincide with the central longitudinal axis of tool body 12.

The lowermost end portion of tool body 12 carries the drill bit cutting portions. An enlarged head 15 has multiple flat surfaces which intersect as will be described more fully hereinafter. Drilling head 15 includes three uppermost generally flat surfaces 16, 17, 18 which are tangent to the outer surface of tool body 12 (Figures 1, 2, and 3). If tool body 12 were positioned vertically, surfaces 16-18 would define vertical planes tangent the tool body 12 outer surface. The flat sides 16, 17, 18 of bit 15 define a generally triangular shape as shown in Figure 4.

A plurality of three cutting blades 22, 23, 24 are mounted generally as shown in Figure 4. Each cutting blade 22-24 carries tooth-like projections 20 spaced apart from one another and along the blades 31, 32, 33 (Figure 4). Projections 20 can be made of tungsten carbide or polycrystalline diamond material. Projections 20 enhance the ability of bit 10 to drill in medium to hard unconsolidated formations, since projections 20 gouge and shear the formations. Projections 20 may be spaced apart from one another and positioned on blades 22-24, so that each blade 22, 23, 24 will make a one-third (1/3) cut in the formation during a rotation of the drill head 15. When so positioned, projections 20 gouge the formation so that it breaks apart. Formation cuttings are swept away by blades 22-24.

The bottom tip of bit 10 provides a flat hexagonal surface 34 (Figures 1, 2, and 4). Multiple surfaces 35-40 each respectively form an obtuse angle with lowermost surface 34. Surfaces 35, 37, 39 are smooth and uncoated surfaces having jet openings 41-43 which outcrop at surfaces 35, 37, 39. Each surface 35, 37, 39 is an inclined surface that forms an acute angle with horizontal.

Openings 41-44 communicate with jets 45-48 (see Figures 3 and 4). Surfaces 36, 38, 40 contain projection 20. Jets 45-48 allow drilling fluids to flow across surfaces 36, 38, 40 and projections 20 and blast away even gummy formation cuttings.

The lowermost tip portion of drill bit 10 at surface 34 is seen in Figure 4. Note that blades 22, 23, 24 extend to surface 34 with one of the blades 24 preferably extending across the surface 34 in a transverse direction as shown in Figure 4.

In the preferred embodiment, each blade 22, 23, 24 terminates at smooth surfaces 62, 63, 64. Thus, each blade 22, 23 is inclined an arcuate angle with respect to vertical as best seen in Figure 1. Surfaces 65, 66, 67 extend from the cylindrical portion of tool body 12 toward the surfaces 62, 63, 64 and define the uppermost limits of the enlarged head 15 portion of tool body 12. Notice that opening 44 and jet 48 are positioned on surface 66.

The entire drill bit 10 can be manufactured of any suitable structural material such as, for example, structural steel with tungsten carbide or polycrystalline diamond projections 20 bonded on each blade 22,23, 24 as shown in Figures 1, 2, 3, and 4. The bonding process requires bores, not shown, to be drilled into blades 22, 23, 24 to receive a bonding material such as a nickel silver compound, not shown, and projections 20. Blades 22, 23, 24, projections 20 and the bonding material are heated to approximately 600° Fahrenheit (320°C). The bonding material is poured into the bores on blades 22, 23, 24 and projections 20 are inserted into the bores. Once blades 22, 23, 24, projections 20 and the bonding material cool, projections 20 become an integral part of blades 22, 23, 24 and can withstand heat generated during the drilling of oil and gas well bores of up to 1200° Fahrenheit (650°C) without becoming separated from blades 22, 23, 24.

In Figure 4, three flow zones are defined by the circular dotted line designated as well bore WB and the flat surfaces 16, 17, 18 as well as the flat inclined surfaces 35, 37, 39. during rotation of the drill bit 10, these "zones" will allow fluid to flow from jet assemblies 44, 45, 46 up to the surface and along the tool body 12 and drill string D. Because the tool is triangularly shaped, the area between the well bore wall which is designated by the dotted lines in Figure 4 and the flat surfaces 16, 17, 18 and 35, 37, 39 will be unoccupied by structure and thus filled with fluid. This fluid is injected through the bore 11 of the tool body 12 and exits jets 45-48 through jet openings 41-44. The fluid then travels upwardly carrying with it cut formation material which is removed from the well bore so that cutting will continue downwardly.

Turning now to the alternative embodiment, drill bit 110 includes a tubular body 112 having at its upper end portion threaded section 14 which is adapted to threadably attach to a drill string. The tool body 112 can provide indentations 13 with flat surfaces, for example, so that a wrench, power tong or the like can be attached to the tool body 112 so that the tool body 112 can be tightened with respect to the drill string. The center of cylindrical bore 11 (not shown) would coincide with the central longitudinal axis of tool body 112.

A plurality of three cutting blades 122, 123, 124 are mounted generally as shown in Figure 5. Each cutting blade 122, 123, 124 carries inserts 120 spaced apart from one another and along the blades 131, 132, 133 (Figure 5). Inserts 120 can be made of tungsten carbide or, preferably, polycrystalline diamond material. Inserts 120 enhance the ability of bit 110 to drill in medium to hard unconsolidated formations, since inserts 120 gouge and shear the formations. Inserts 120 may be spaced apart from one another and positioned on blades 122-124, so that each blade 122, 123, 124 will make a one-third (1/3) cut in the formation during a rotation of the drill head 115. When so positioned, inserts 120 gouge the formation so that it breaks apart. Formation cuttings are swept away by blades 122-124.

The bottom tip of bit 110 provides a flat surface 134 (Figures 5 and 8). Surfaces 135, 137, 139 are smooth and uncoated surfaces having jet openings 141-143 which outcrop at surfaces 135, 137, 139, respectively.

Openings 141, 142, 143 communicate with jets 145, 146, 1478 (see Figures 5 and 8). Surfaces 136, 138, 140 contain inserts 120. Jets 145-147 allow drilling fluids to flow across surfaces 136, 138, 140 and inserts 120 and blast away even gummy formation cuttings.

The lowermost tip portion of drill bit 110 at surface 134 is seen in Figure 5. Note that blades 122, 123, 124 extend to surface 134 with one of the blades 122 preferably extending across the surface 134 in a transverse direction as shown in Figure 5.

In the alternative embodiment, blades 122, 123, 124 terminate at smooth surfaces 62, 63, 64, respectively. Thus, each blade 122, 123, 124 is inclined an arcuate angle with respect to vertical as best seen in Figure 8. Surfaces 65, 66, 67 extend from the cylindrical portion of tool body 112 toward the surfaces 62, 63, 64 and define the uppermost limits of the enlarged head 115 portion of tool body 112.

The entire drill bit 110 can be manufactured of any suitable structural material such as, for example, structural steel with tungsten carbide or polycrystalline diamond inserts 120 bonded on each blade 122, 123, 124 as shown in Figures 5 and 8. The bonding process requires bores 220 (Figure 7) to be drilled into blades 122, 123, 124 to receive a bonding material such as a nickel silver compound, not shown, and inserts 120. Blades 122, 123, 124, inserts 120 and the bonding material are heated to approximately 600° Fahrenheit (320°C). The bonding material is poured into the bores 220 on blades 122, 123, 124 and inserts 120 are inserted into bores 220. Once blades 122, 123, 124, inserts 120 and the bonding material cool, inserts 120 become an integral part of blades 122, 123, 124 and can withstand heat generated during the drilling of oil and gas well bores of up to 1200° Fahrenheit (650°C) without becoming separated from blades 122, 123, 124.

Inserts 120 include a cylindrical cutting portion 222 and a cylindrical insert portion 223, the butting ends of portions 222 and 223 being mitered. Inserts 120 are preferably oriented such that the central axis 221 of the outcropping cylindrical portion 222 of insert 120 is generally parallel to the tangent 310 of the outer curved cut formed by drill bit 110 during use, rather than as shown in Figure 6. It has been found that the orientation of insert 120 shown in Figure 7 extends the useful life of inserts 120.

The above construction and operation provides an improved oil well drill bit that has particular utility in unconsolidated formations, commonly called "gumbo mud".

Because many varying and different embodiments may be made within the scope of the inventive concept herein taught, and because many modifications may be made in the embodiments herein detailed in accordance with the descriptive requirement of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

What is claimed as invention is:

CLAIMS

1. A drill bit apparatus for use in oil/gas well drilling with a drill string comprising:

a) a tool body having a generally triangular horizontal cross-sectional area with a generally flat, blunt lower tip portion;

b) means for forming a removable connection between the tool body and a drill string;

c) the tool body having an open-ended flow conveying longitudinal internal bore for circulating fluids between the tool body and a drill string connected thereto;

d) three longitudinal, radially spaced apart blade members each mounted upon the tool body and including at least one blade extending to and substantially across the blunt tip portion, each blade member extending away from the tool body in both lateral and longitudinal directions and including two circumferentially spaced radially extending surfaces that transverse away from the tool body and an outermost circumferential surface that connects the outer edges of each pair of radially extending surfaces to define the outer cut and outer dimensional shape of each blade member and the cut during use;

e) a plurality of polycrystalline diamond inserts that have a cylindrical portion outcropping the outermost circumferential surface of the blade, the inserts being spaced along the outermost circumferential surface of each blade, each insert oriented so that the central axis of the outcropping cylindrical portion is generally parallel to the tangent of the outer curved cut formed by the drill bit during use; and

f) one or more jets extending between the tool bore and the flat flow zone surfaces at the tapered section of the tool body above the tip portion.

2. The apparatus of Claim 1 wherein the blade members and the tool body define a channel adjacent the blade members so that cuttings and fluids can be directed away from the blade members and up the length of the tool body as a well bore hole is cut.

3. The apparatus of Claim 1 wherein the lower section of the tool body terminates at a generally flat end portion of the tool body and the radially extending surfaces of the blade members extend beyond the flat end portion.

4. The apparatus of Claim 1 wherein the outermost circumferential surfaces of each blade member include first and second flattened surfaces that form an obtuse angle.

5. The apparatus of Claim 3 wherein each of the blade members extend to the flat end portion of the tool body.

6. The apparatus of Claim 1 wherein the inserts are spaced apart between one half inch (1.27 cm) and one inch (2.54 cm).

7. A drill bit apparatus for use in oil/gas well drilling with a drill string comprising:

a) a tool body having a generally triangular horizontal cross-sectional area with a lower tip portion;

b) means for forming a removable connection between the tool body and a drill string;

c) the tool body having an open-ended flow conveying longitudinal internal bore for circulating fluids between the tool body and a drill string connected thereto;

d) three longitudinal, radially spaced apart blade members each mounted upon the tool body;

e) three generally flat flow zone surfaces which span between the blade members, each surface including generally vertical surface portions and inclined surface portions, the substantially vertical surface portions generally defining an upper, large horizontal cross-section of the tool body and the inclined surfaces portions generally defining a lower, tapered section of the tool body;

f) at least one of said blade members having contact surface area means carried thereon for defining the radial dimensional limit of the tool body during a rotation of the tool body and a connected drill string;

g) each blade carrying a plurality of spaced apart, tooth-like projections; and

h) one or more jets extending between the tool bore and the flat flow zone surfaces at the tapered section of the tool body above the top portion.

8. The apparatus of Claim 7 wherein the blade members are an integral portion of the tool body.

9. The apparatus of Claim 7 wherein the flow zone surfaces of the lower section of the body define a channel adjacent the blade members so that cuttings and fluids can be directed away form the blade members and up the length of the tool body as a well bore hole is cut.

10. The apparatus of Claim 7 wherein the tooth-like projections are of a tungsten carbide material.

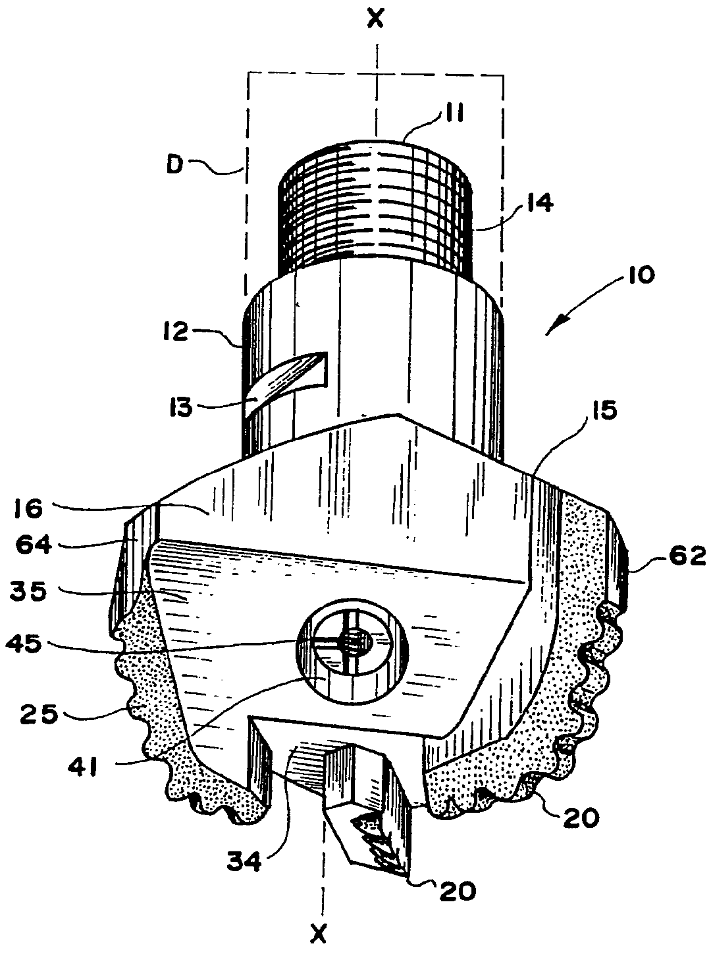

FIG. 1

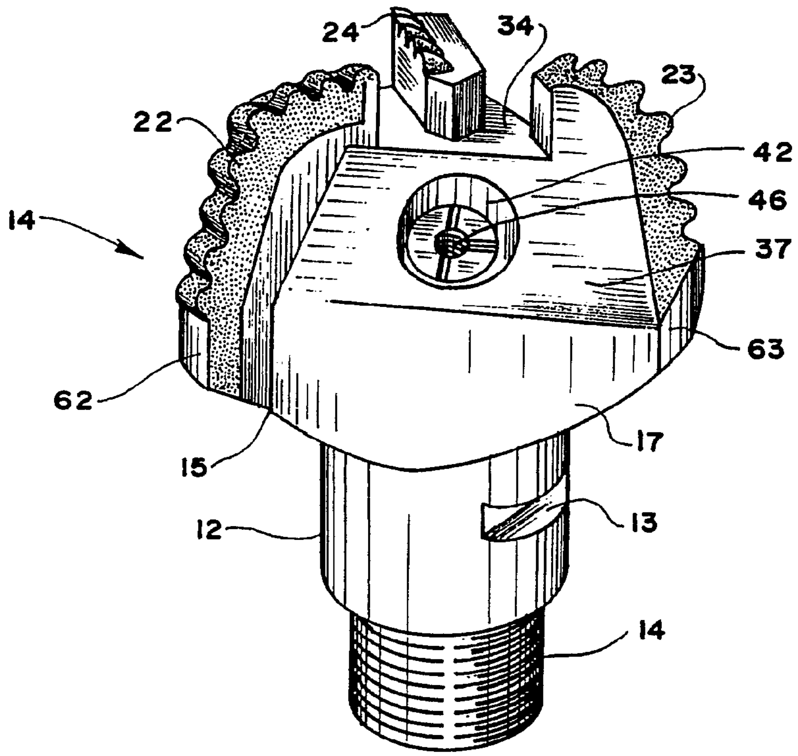

FIG. 2

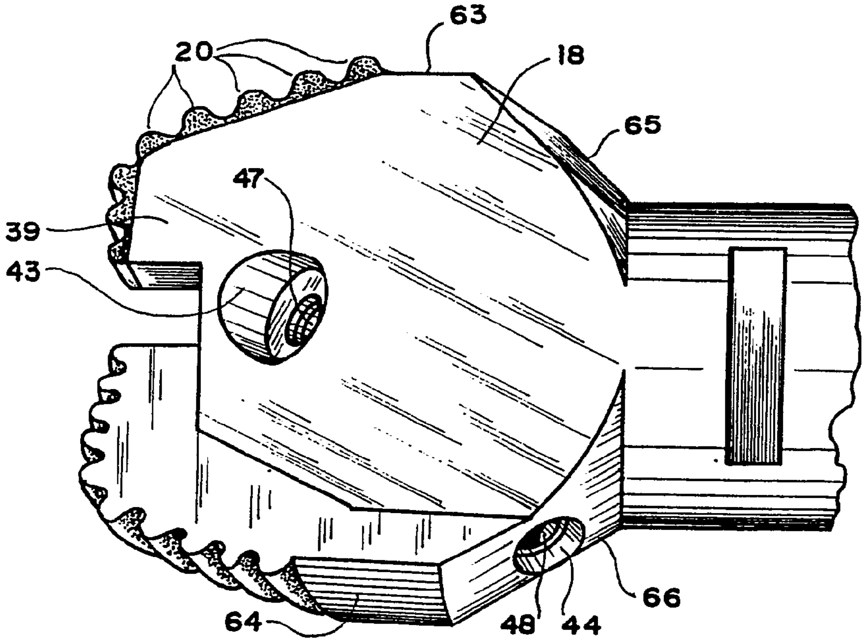

FIG. 3

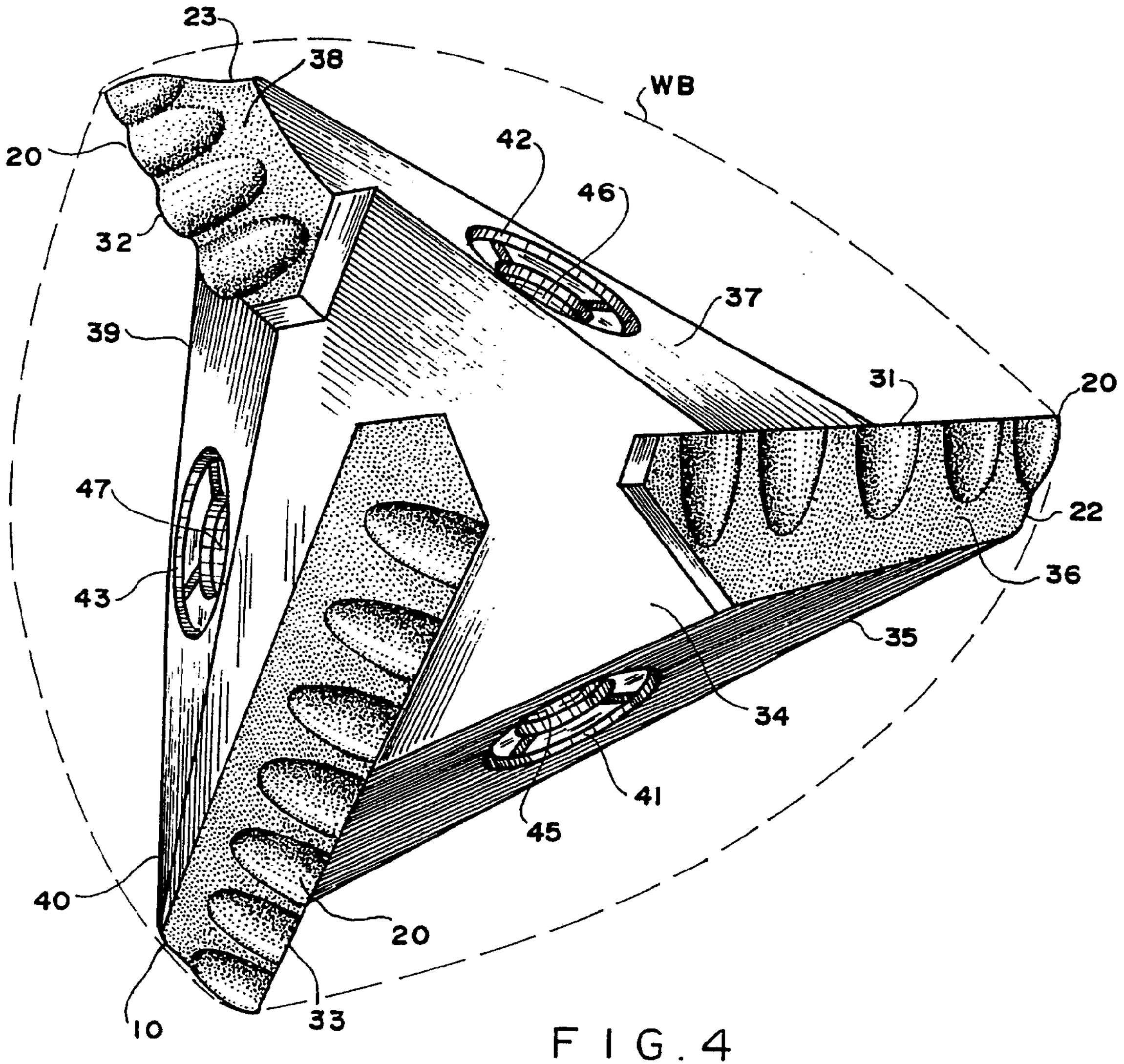

FIG. 4

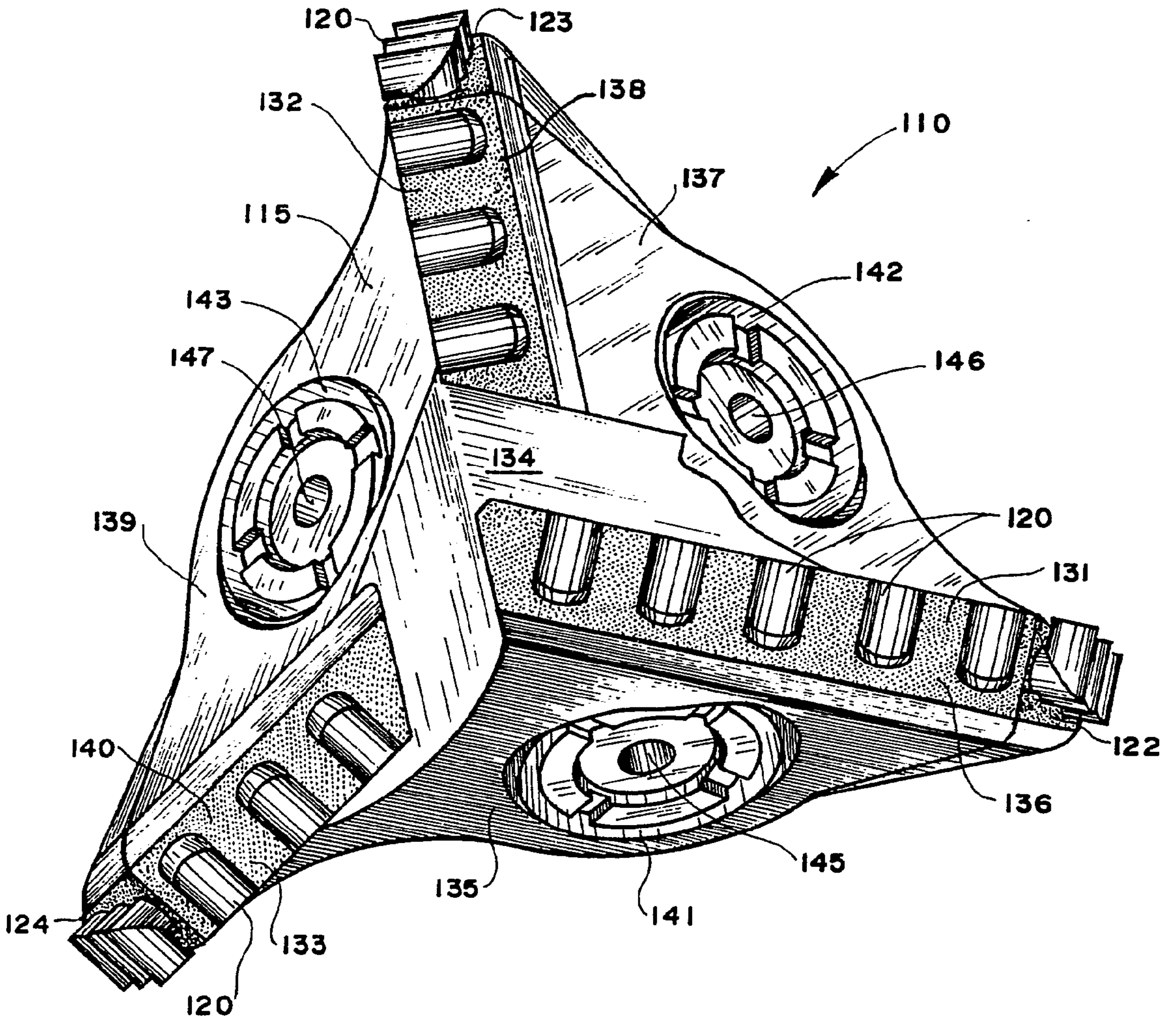

FIG. 5

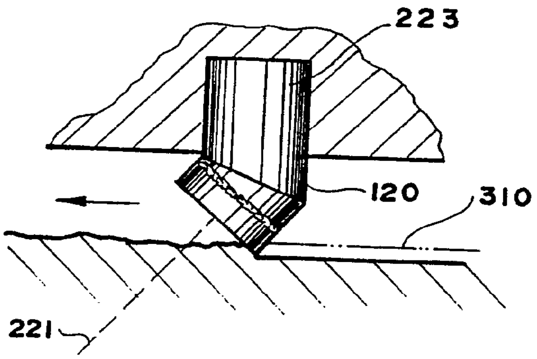

FIG. 6

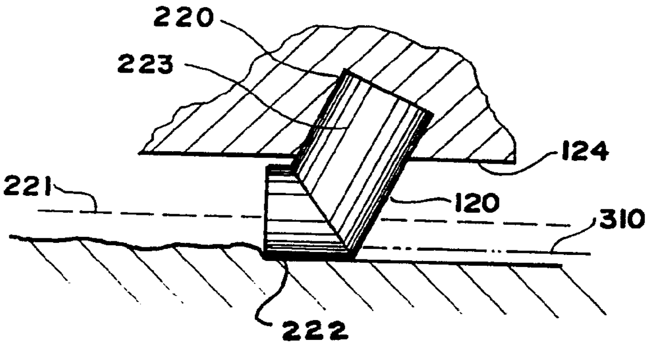

FIG. 7

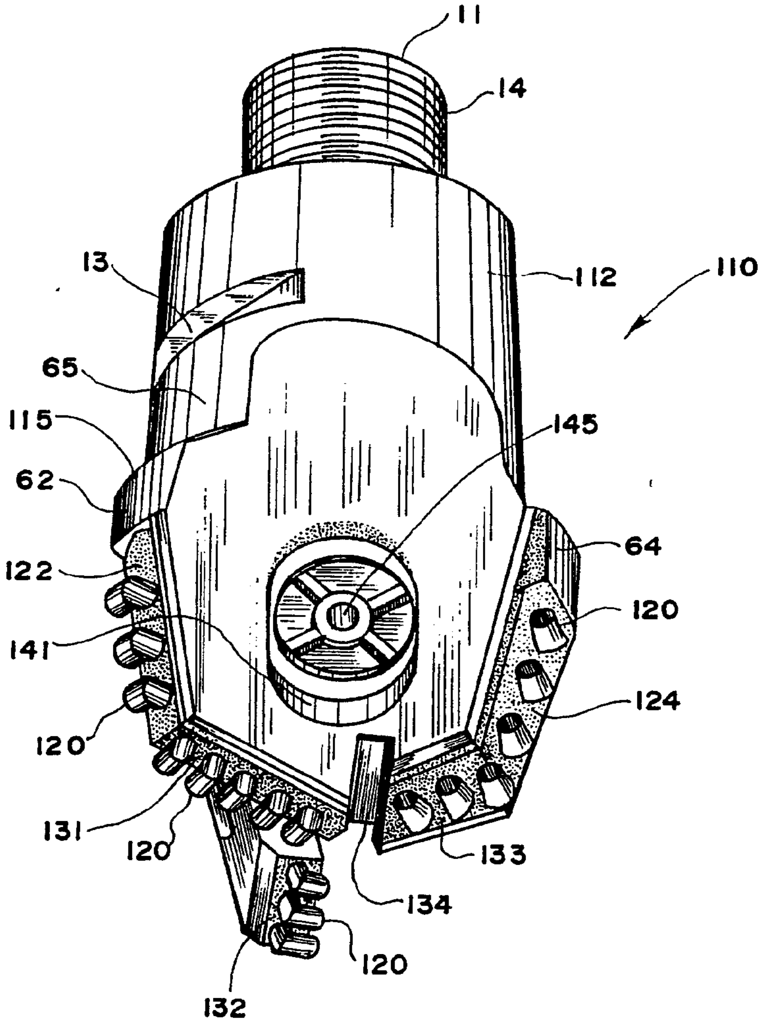

FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/US90/01886

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 3

According to International Patent Classification (IPC) or to both National Classification and IPC
INT. CL. (5): E21B 10/26; E21B 10/46; E21B 10/60
U.S. CL: 175/329,385,393,410

II. FIELDS SEARCHED

Minimum Documentation Searched 4

Classification System	Classification Symbols
U.S.	175/329,379,385,391,393,394,397,398,400,401 175/409,410,411

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 5

III. DOCUMENTS CONSIDERED TO BE RELEVANT 14

Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No. 18
Y	US, A, 4,683,965 (WALTON ET AL.) 04 August 1987 see column 2, line 44 through column 3, line 28 and Figures 1,2,3 and 5.	1-10
A	US, A, 4,711,144 (BARR ET AL.) 08 December 1987 see column 5, line 26 through column 6, line 2, column 6 lines 31-39 and Figures 1,3,5 and 6.	1-10
A	US, A, 4,733,734 (BARDIN ET AL.) 29 March 1988 see column 1 lines 57-62 and Figures 1 and 3.	1-10
A	EP, A, 295,045 (SABADOS ET AL.) 14 December 1988 see column 4 line 45 through column 5 line 56 and Figures 1-7.	1-10
A	GB, A, 585,709 (HURDITCH ET AL.) 20 february 1947 see page 4 lines 7-42 and Figures 1 and 3.	7-10
A	US, A, 3,043,384 (GAULT ET AL.) 10 July 1962 see column 1 line 61 through column 2 line 72 in particular column 2 lines 31-35, and Figures 1-4.	7-10
A	US, A, 1,923,488 (HOWARD ET AL.) 22 August 1933 see page 2 line 141 through page 3 line 11 and Figure 1.	7-10

* Special categories of cited documents: 15

"A"	document defining the general state of the art which is not considered to be of particular relevance
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"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&"	document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 2 19 JUNE 1990	Date of Mailing of this International Search Report 2 25 JUL 1990
International Searching Authority 1 ISA/US	Signature of Authorized Officer 20 HOANG C. DANG

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No [18]
A	SU, A, 468,987 (MATVEEV) 18 July 1975 see projections 7 and 8 on blades 4,5 and 6 in the drawings.	7-10
A	US, A, 4,515,227 (CERKOVNIK) 07 May 1985 see column 3 lines 27-58 and Figure 3.	1-10
A	SU, A, 840,272 (NOVCH) 23 June 1981 see Figures 1 and 2.	1-10